# Tailless Wonders



Ala Voladora, the Final Design

# Mission Objectives

- *Unconventional Photorecon Aircraft*
- *Comply with Request for Proposal*
- *Challenge limits of student design capability*
- *Pursue absolute excellence*

# *The Tailless Wonders*



- *Craig Skoch*
- *Rob McDonald*
- *Sergio Esteban*
- *Chris DeBons*
- *Amy Szyhowski*
- *Keith Gray*

# *Aircraft Layout*

- *Aspect Ratio*        6
- *Taper Ratio*        0.6
- *Sweep Angle*        $35^o$
- *Washout Angle*        $4^o$
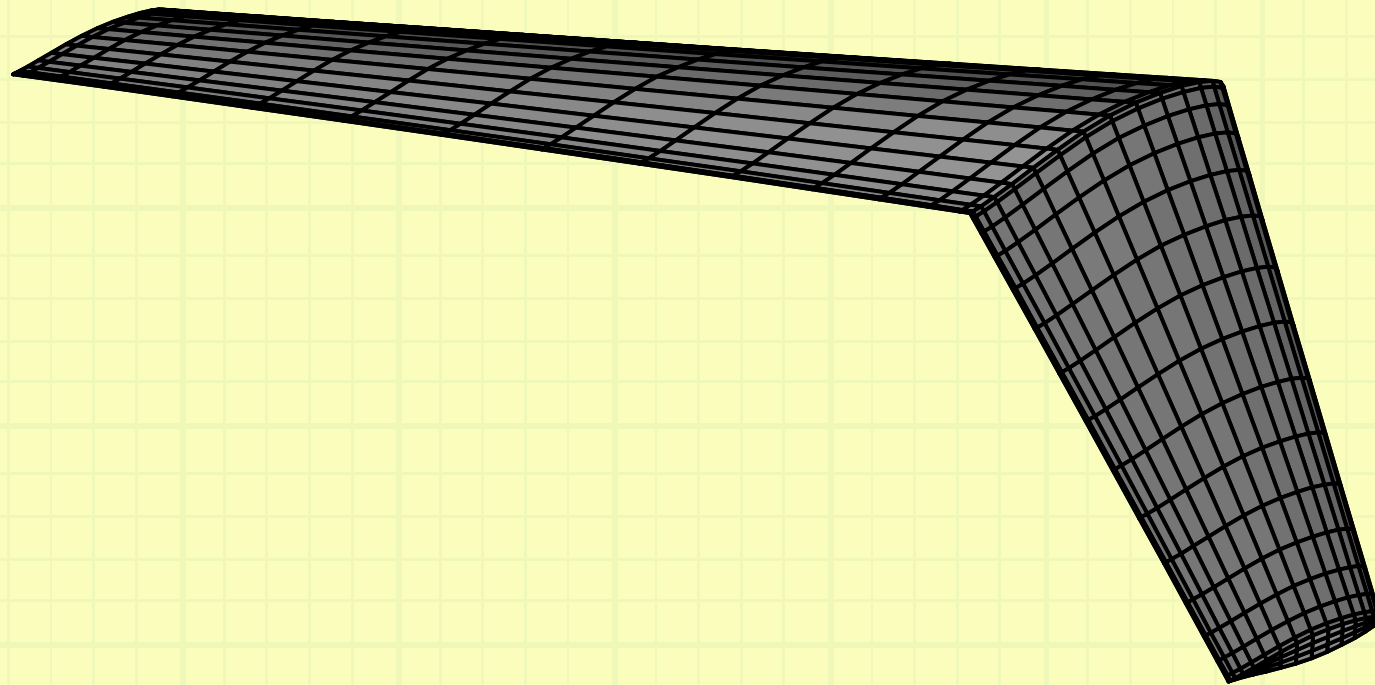- *Wingspan*        *8 ft.*

# Aerodynamics

- *Oswald Efficiency*    0.856
- *Static Margin*    10%
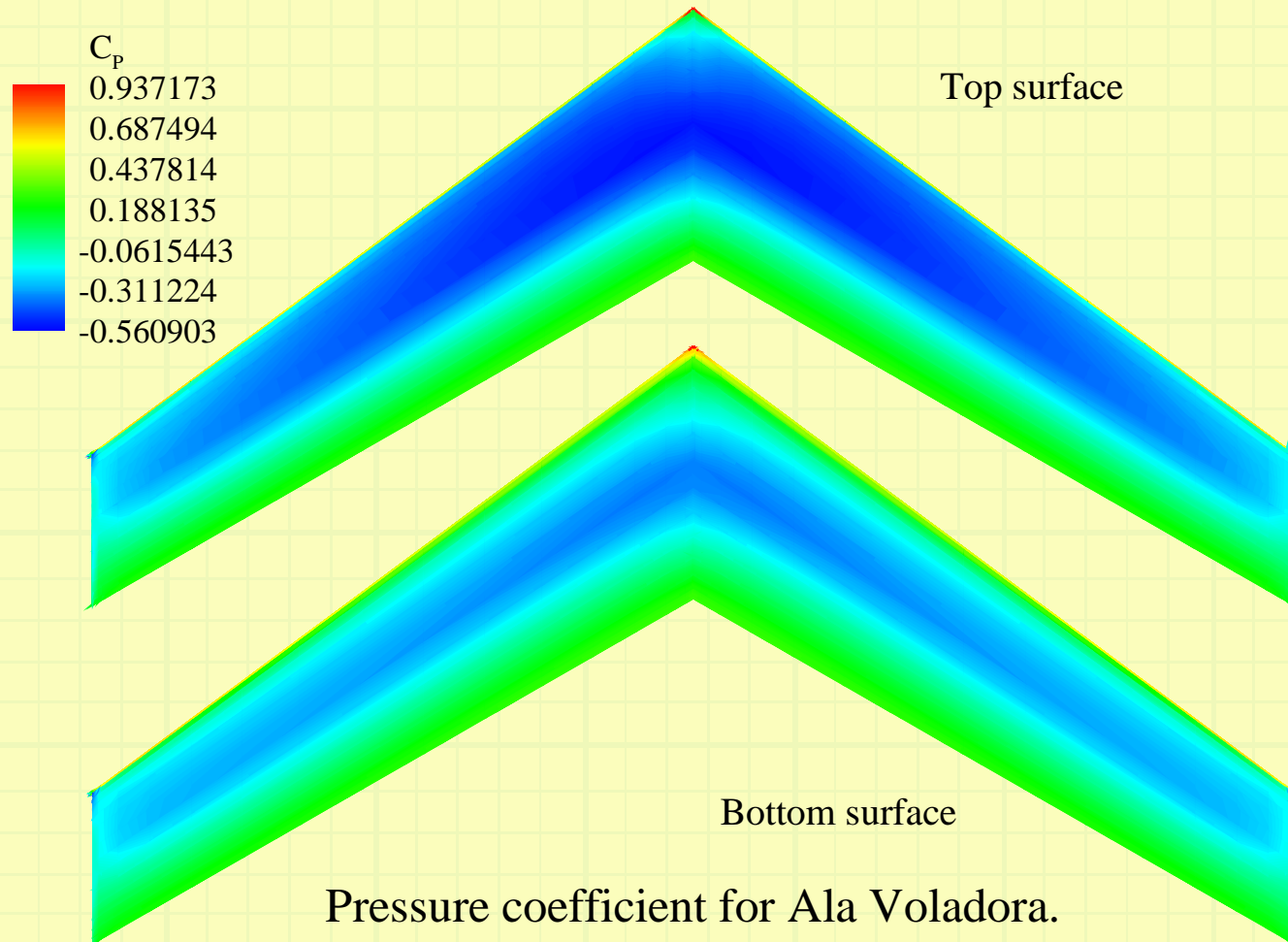- $C_{Do}$    0.011
- $C_{mo}$    0.024
- $L/D_{max}$    21
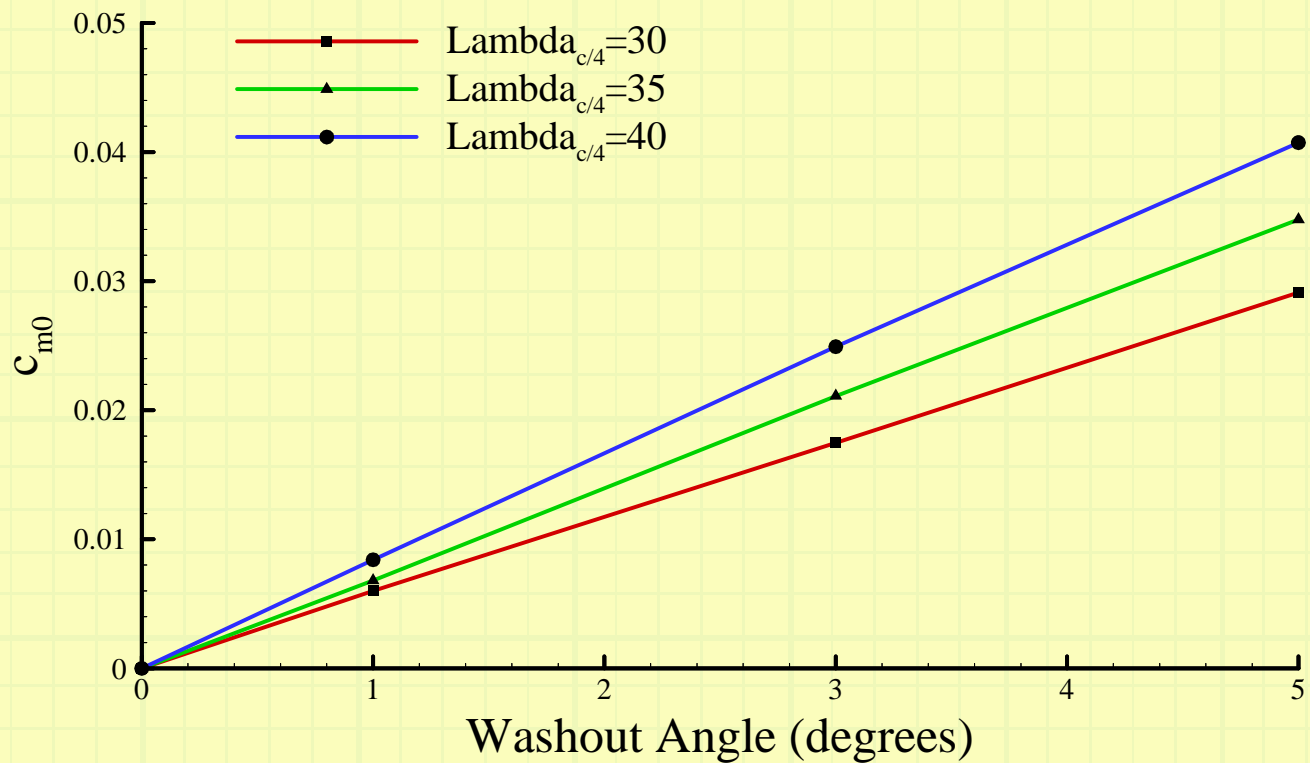
# *Panel Scheme*

Panel arrangement about Ala Voladora.

# *PMARC Solution*



C_P
0.937173
0.687494
0.437814
0.188135
-0.0615443
-0.311224
-0.560903

Top surface

Bottom surface

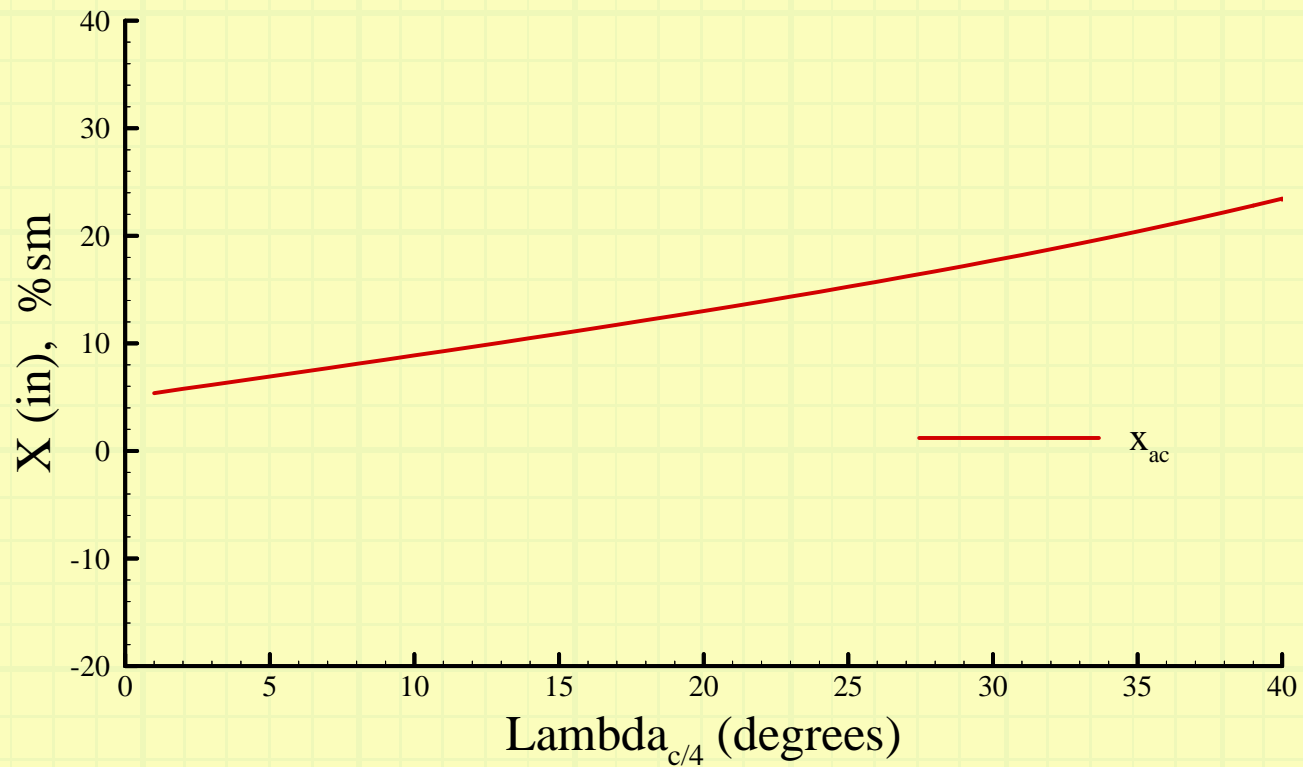Pressure coefficient for Ala Voladora.

# *Aerodynamic Design*



Zero lift moment coefficient as a function
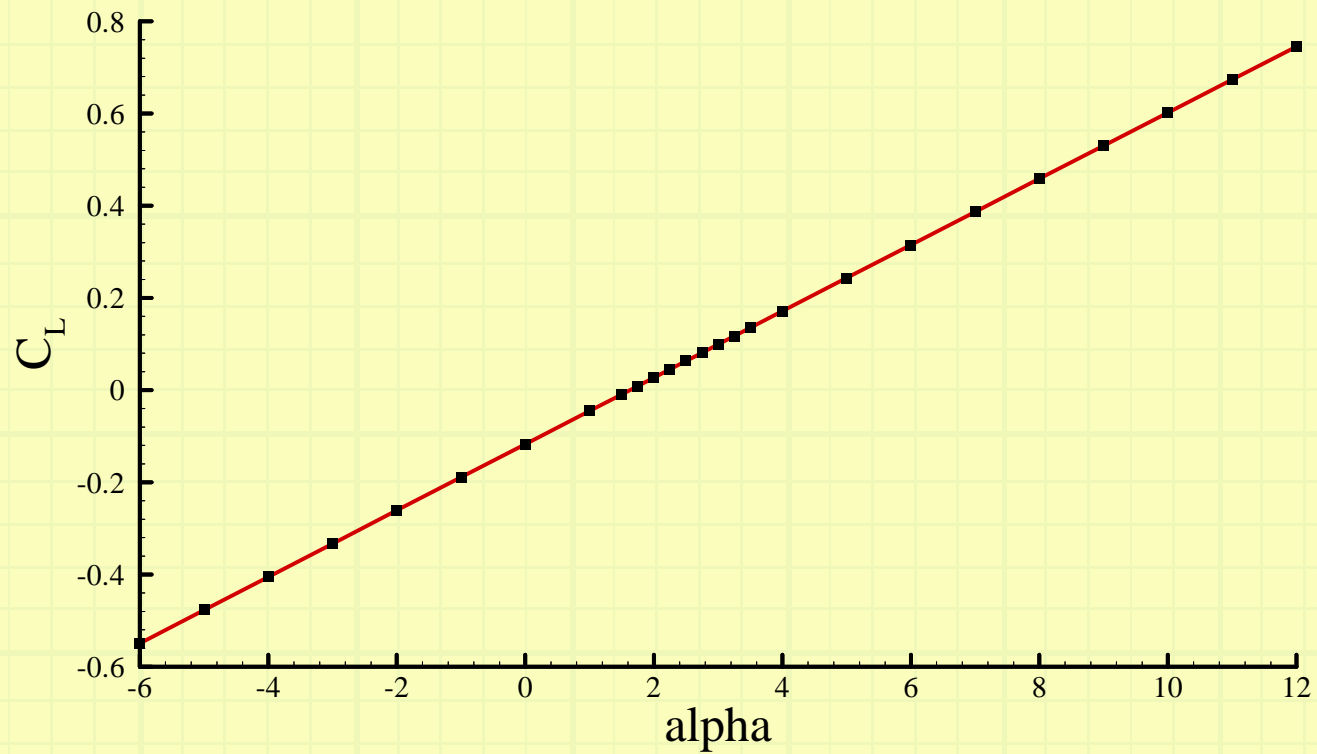of washout angle for Ala Voladora.

# *Sweep Selection*



Aerodynamic center location as a function
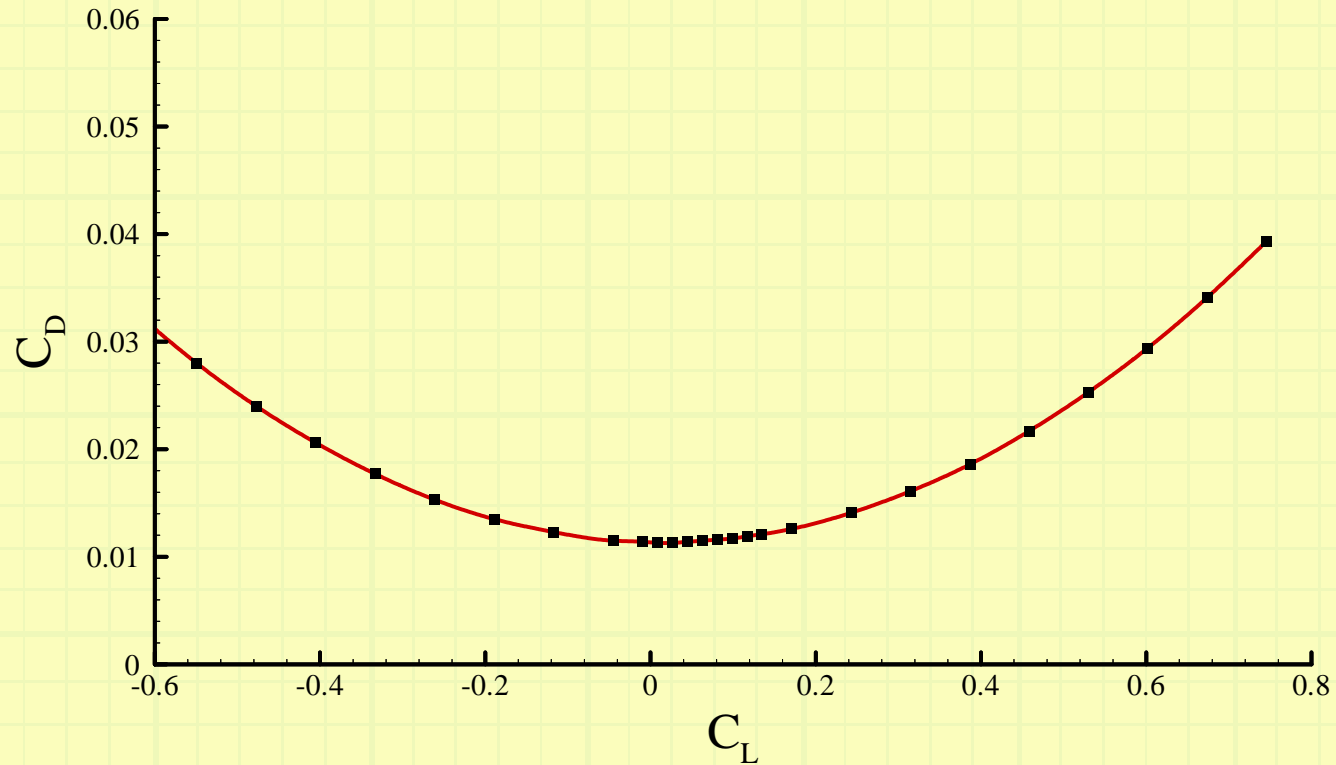of sweep angle for Ala Voladora.

# *Lift Curve*



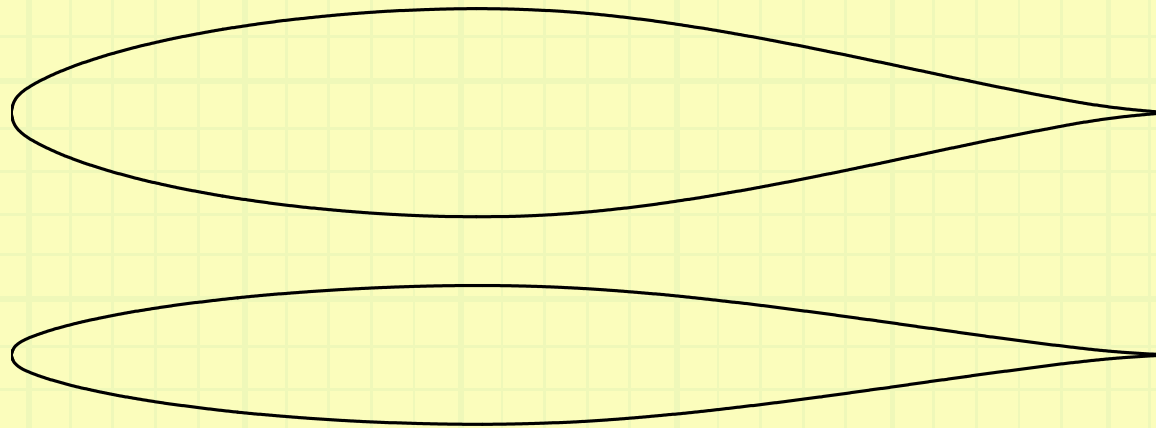Lift coefficient as a function of angle of attack for Ala Voladora.

# *Drag Polar*



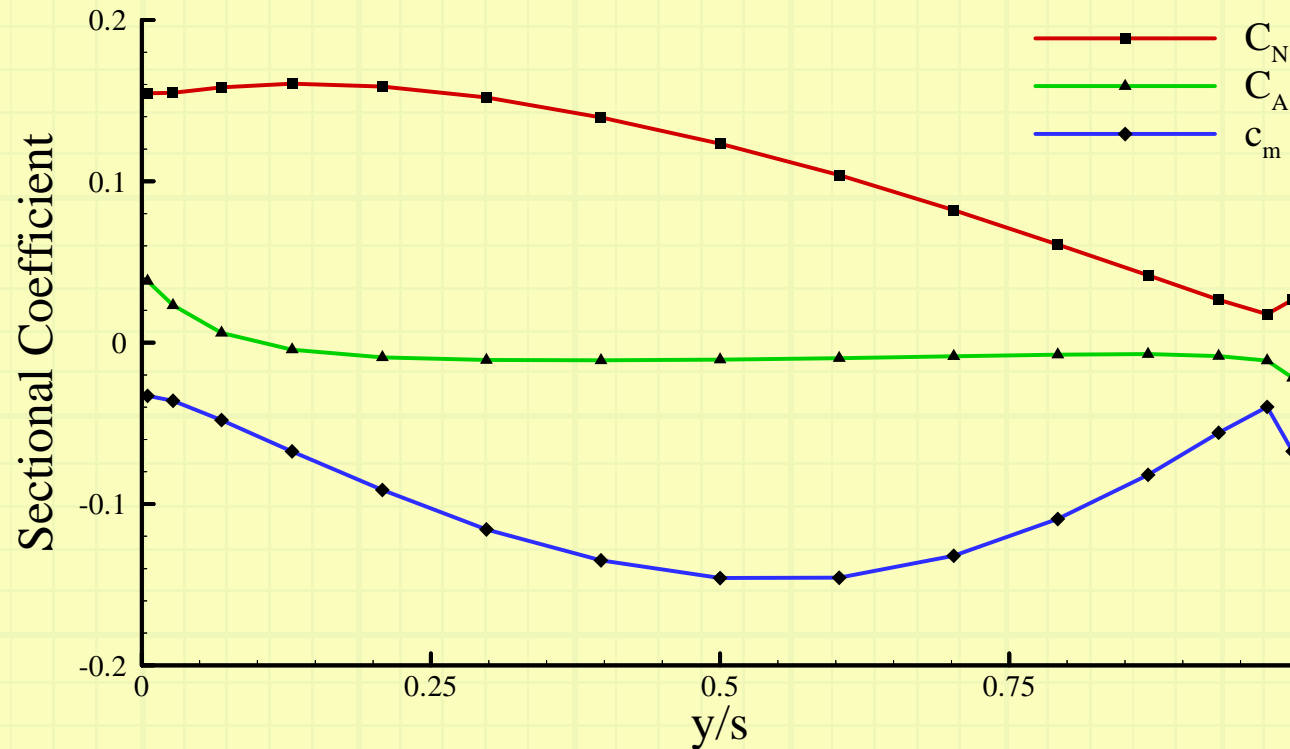Total drag as a function of lift coefficient for Ala Voladora.

# *Airfoil*

Root and tip airfoil for Ala Voladora, NACA $65_3$-0018 and NACA $65_1$-0012.
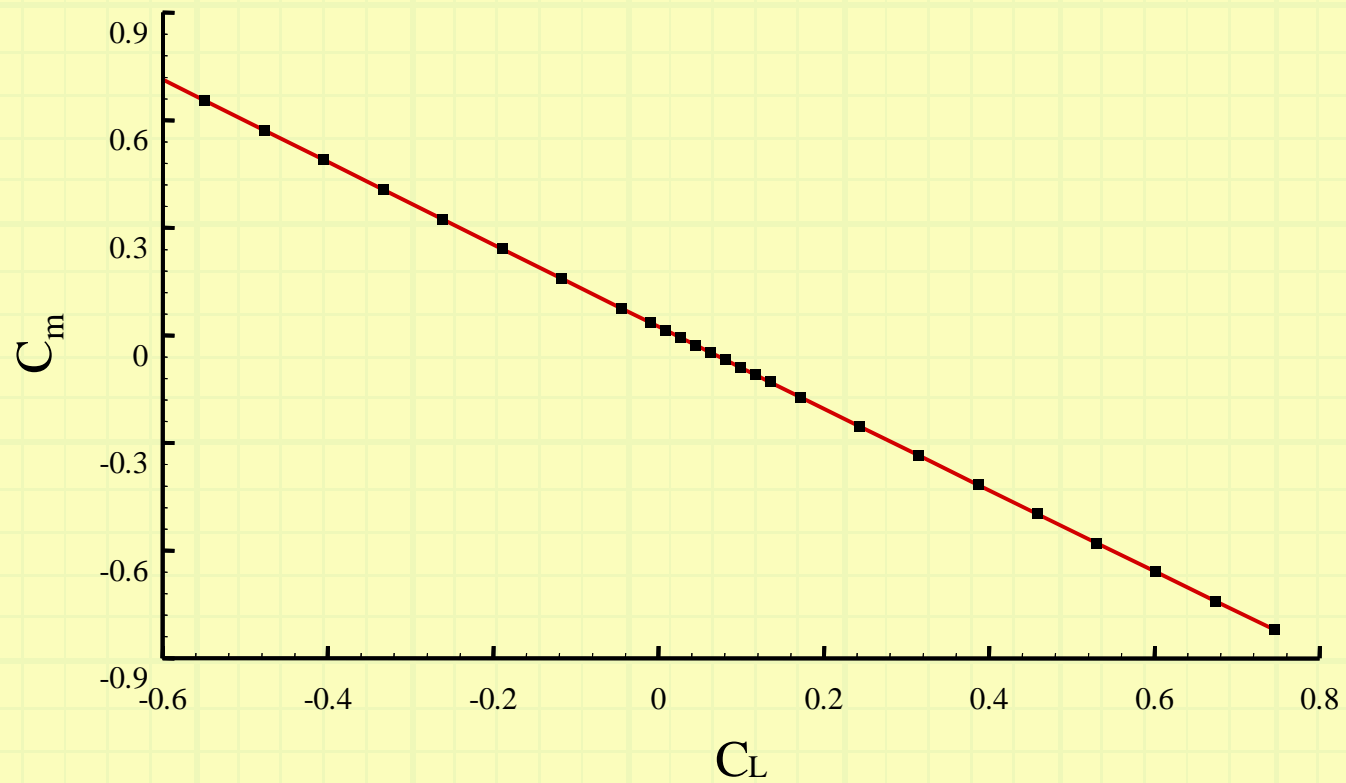
# *Aerodynamic Load Distribution*



Section normal force, axial force and moment coefficient
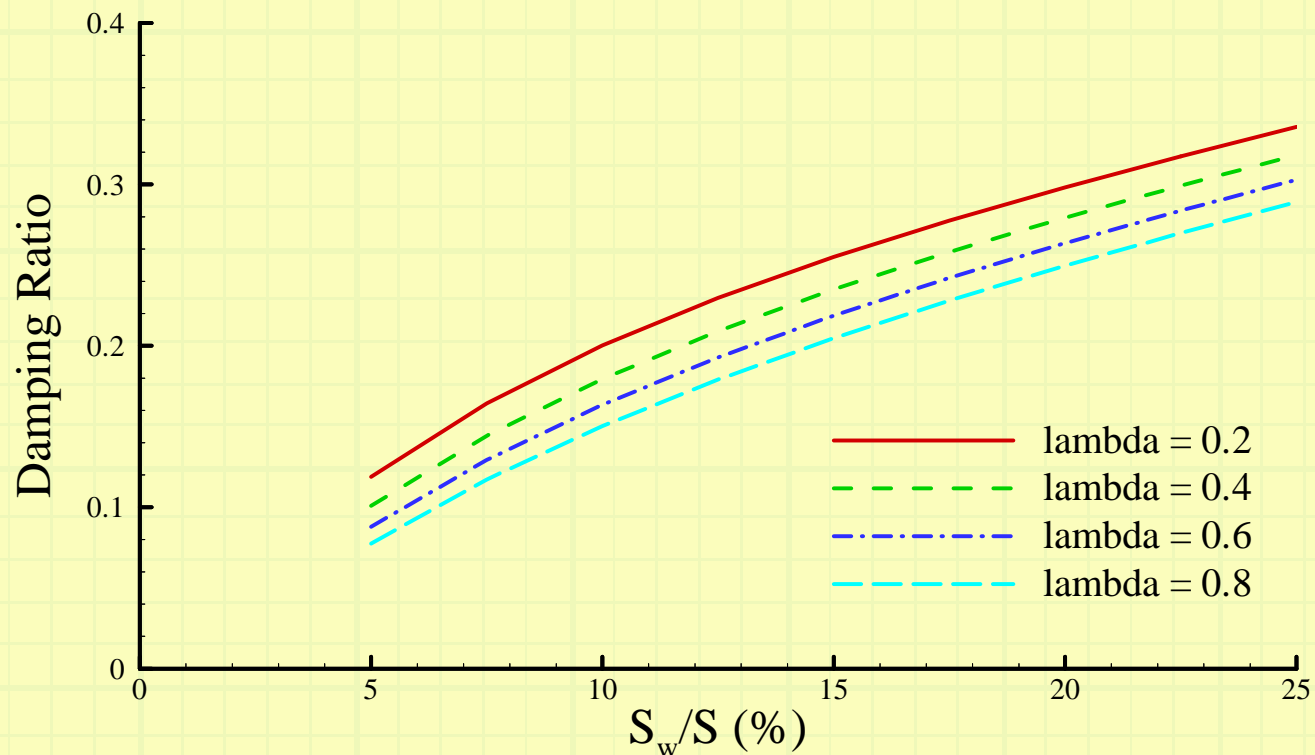as a function of spanwise location for Ala Voladora.

# *Pitching Moment*



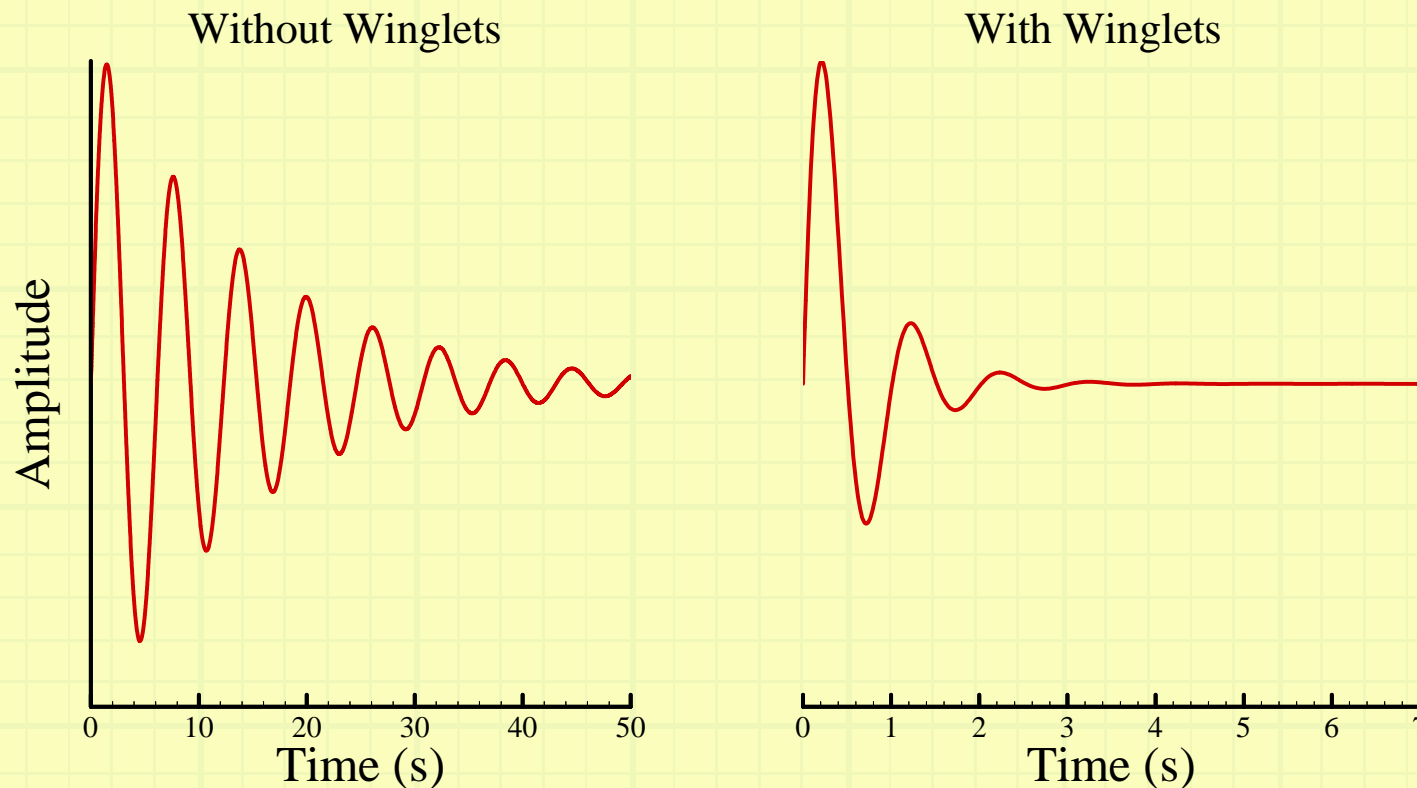Pitching moment coefficient as a function of lift coefficient for Ala Voladora.

# *Winglet Design*



Dutch roll damping ratio as a function of
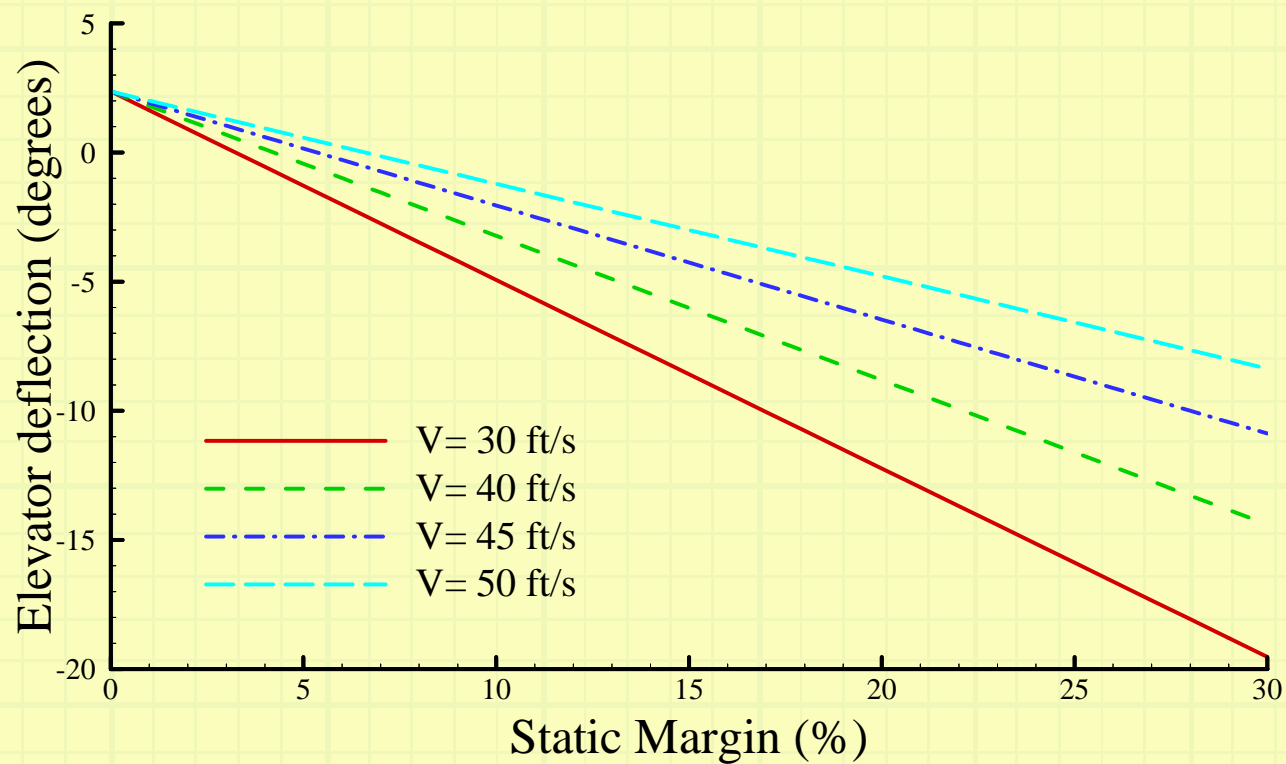winglet area for winglet sweep of 40 degrees.

# *Winglet Effect on Dutch Roll*

Without Winglets

With Winglets

Amplitude

Time (s)

0   10   20   30   40   50

Time (s)

0   1   2   3   4   5   6   7

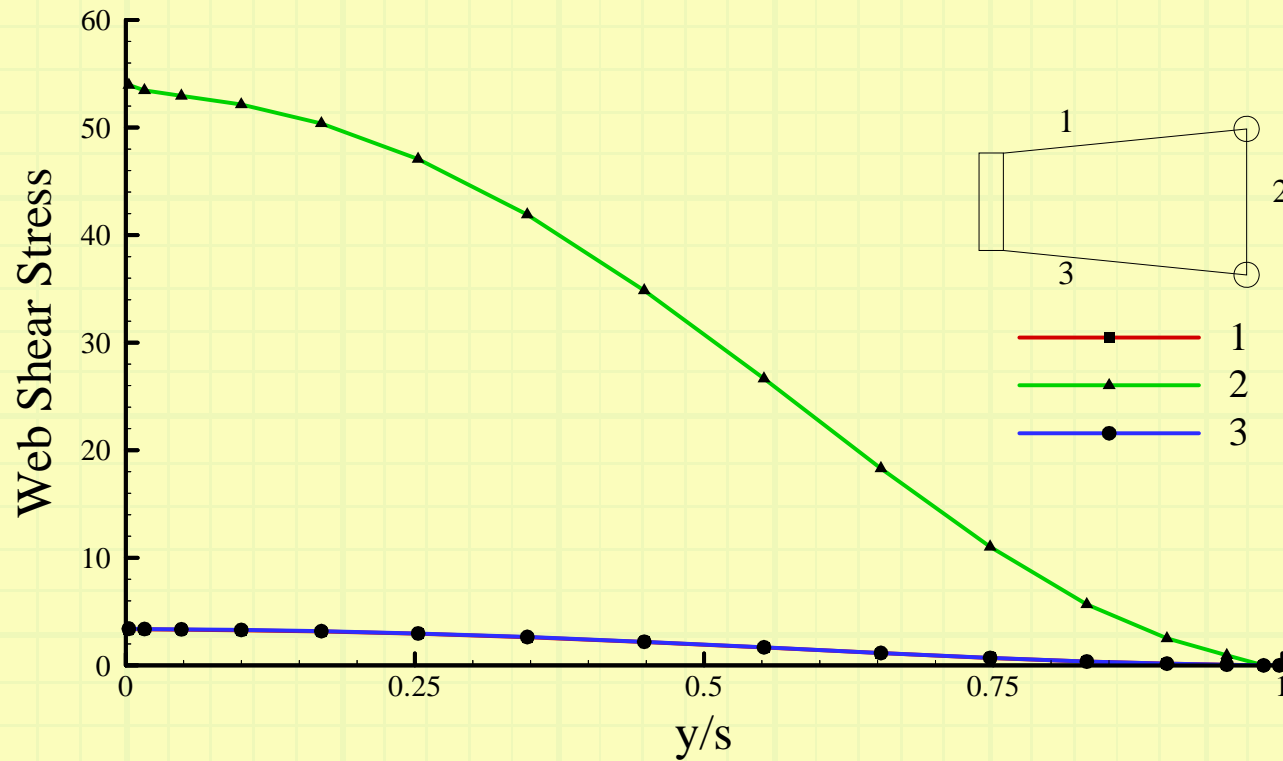Dutch roll response following an impulse perturbation.

# *Elevator Trim Calculations*



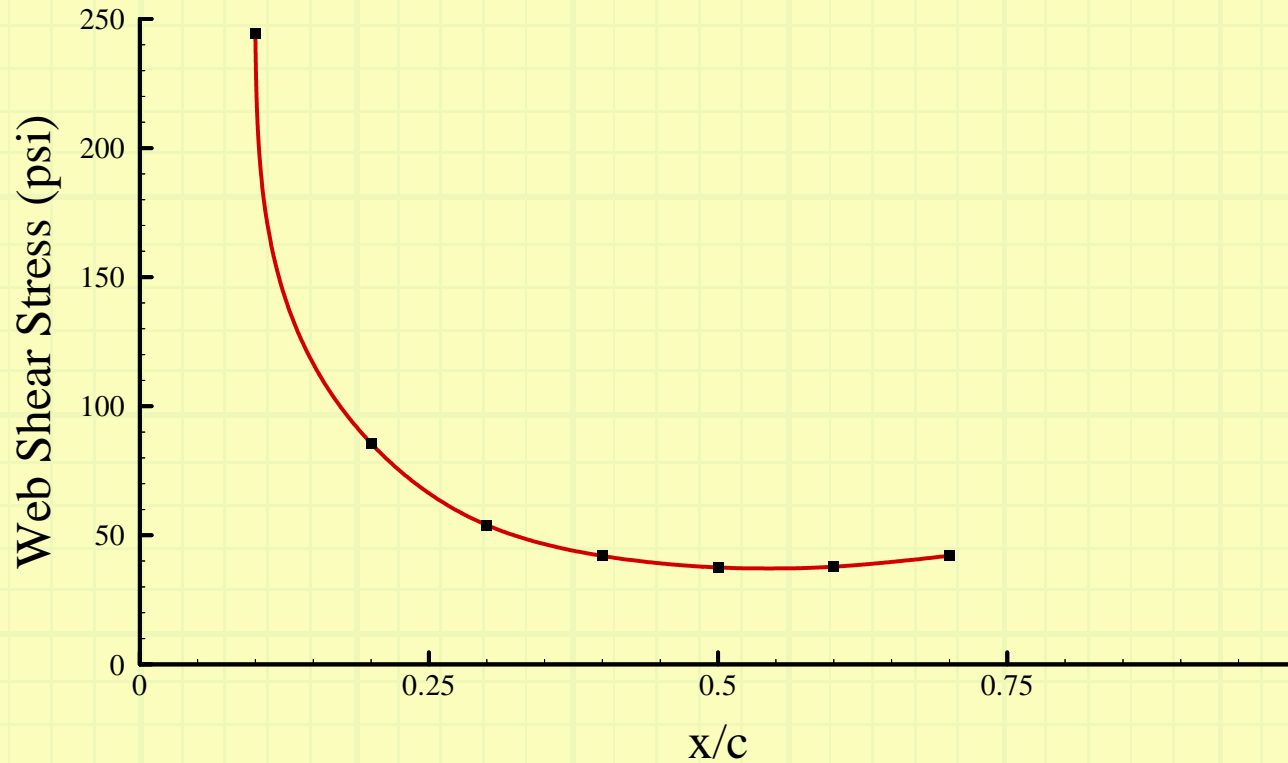Trim elevator deflection as a function of static margin.

# *Shear Stress Distribution*



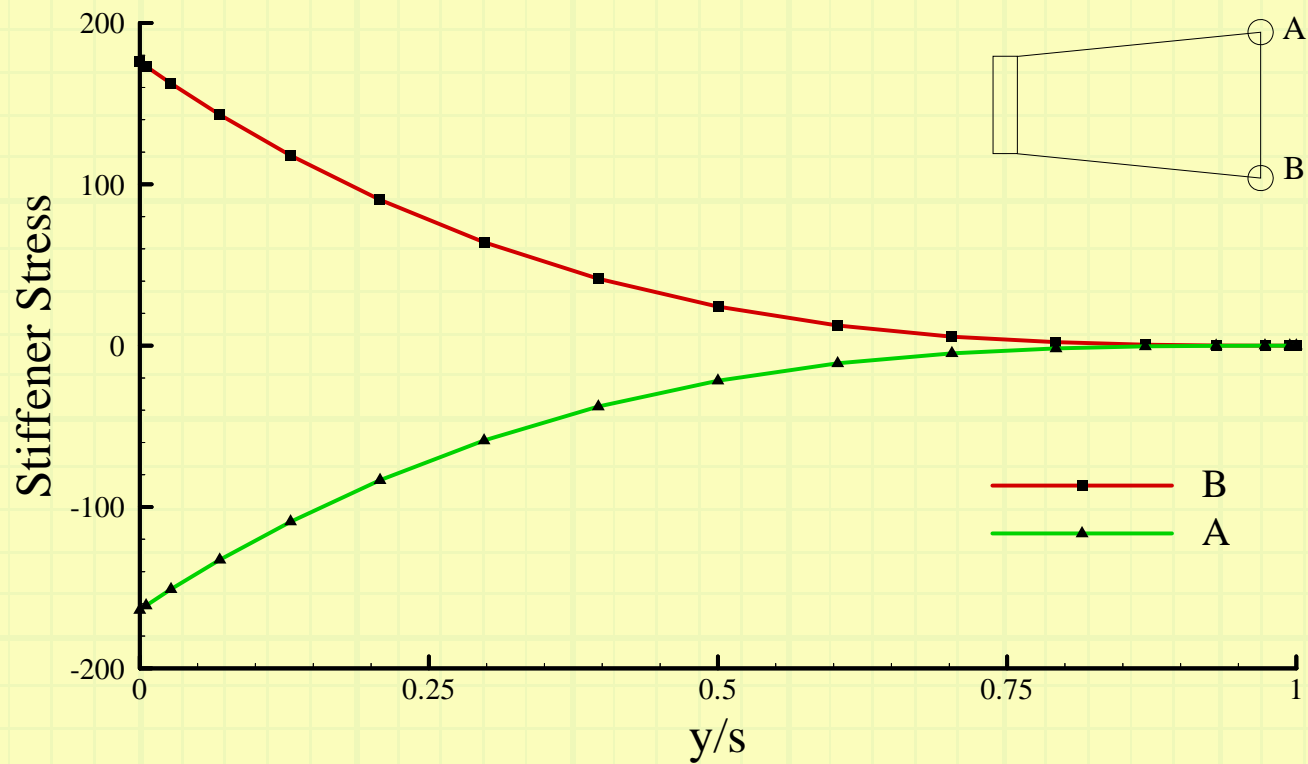Shear stress as a function of spanwise location for Ala Voladora.

# *Structures Design*



Maximum web shear stress as a function of
I-Beam location for Ala Voladora.

# *Stress Distribution*



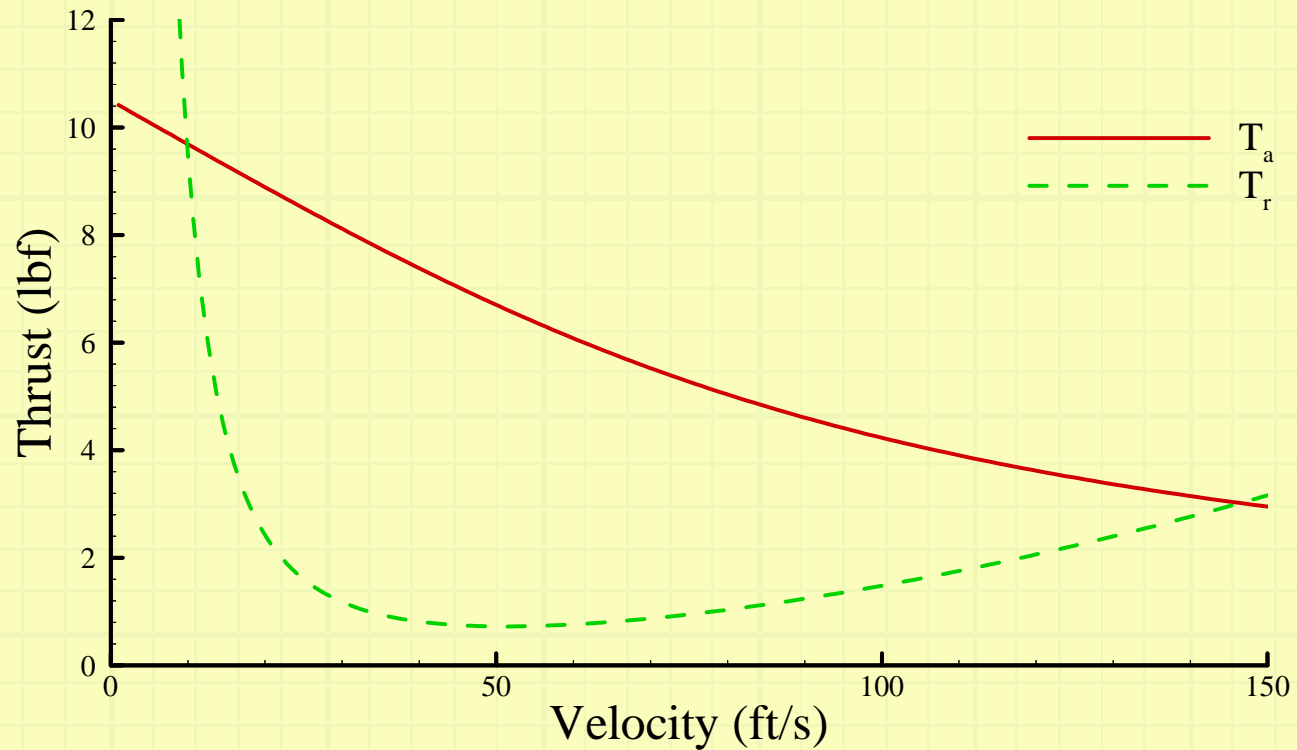Stiffener stress as a function of spanwise location for Ala Voladora.

# *Performance*

- $V_{max}$        146 ft/s
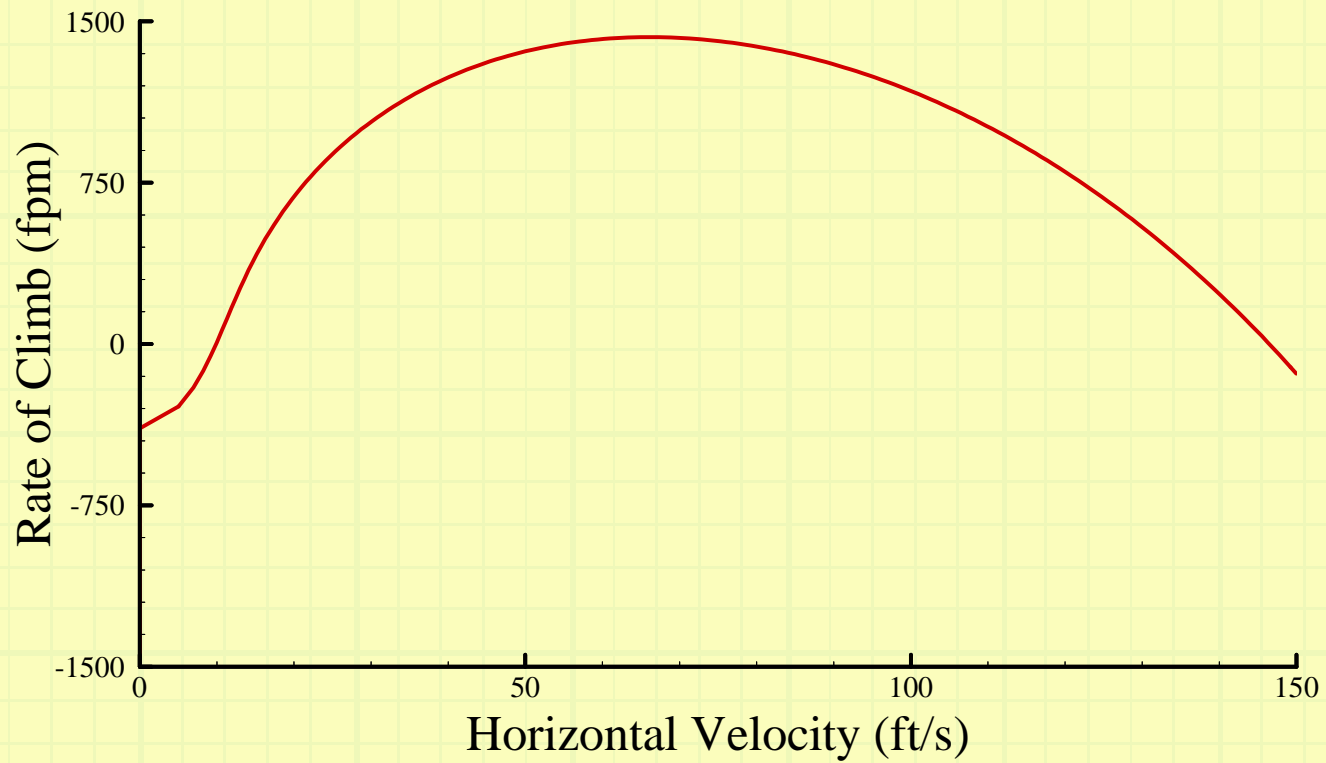- $RC_{max}$     1426 ft/m

# *Thrust Required and Available*



Thrust required and Thrust available as a function of velocity for Ala Voladora.
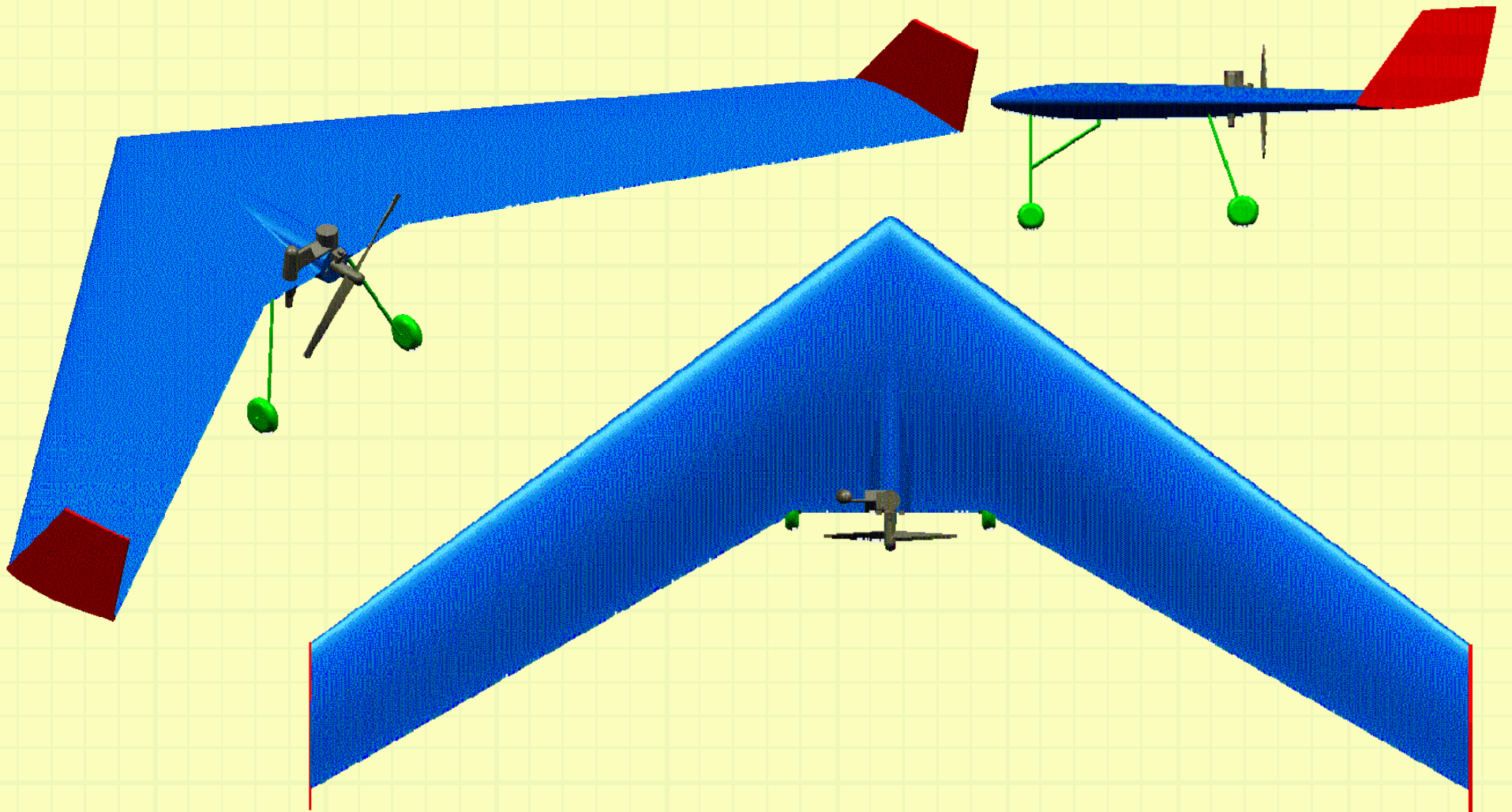
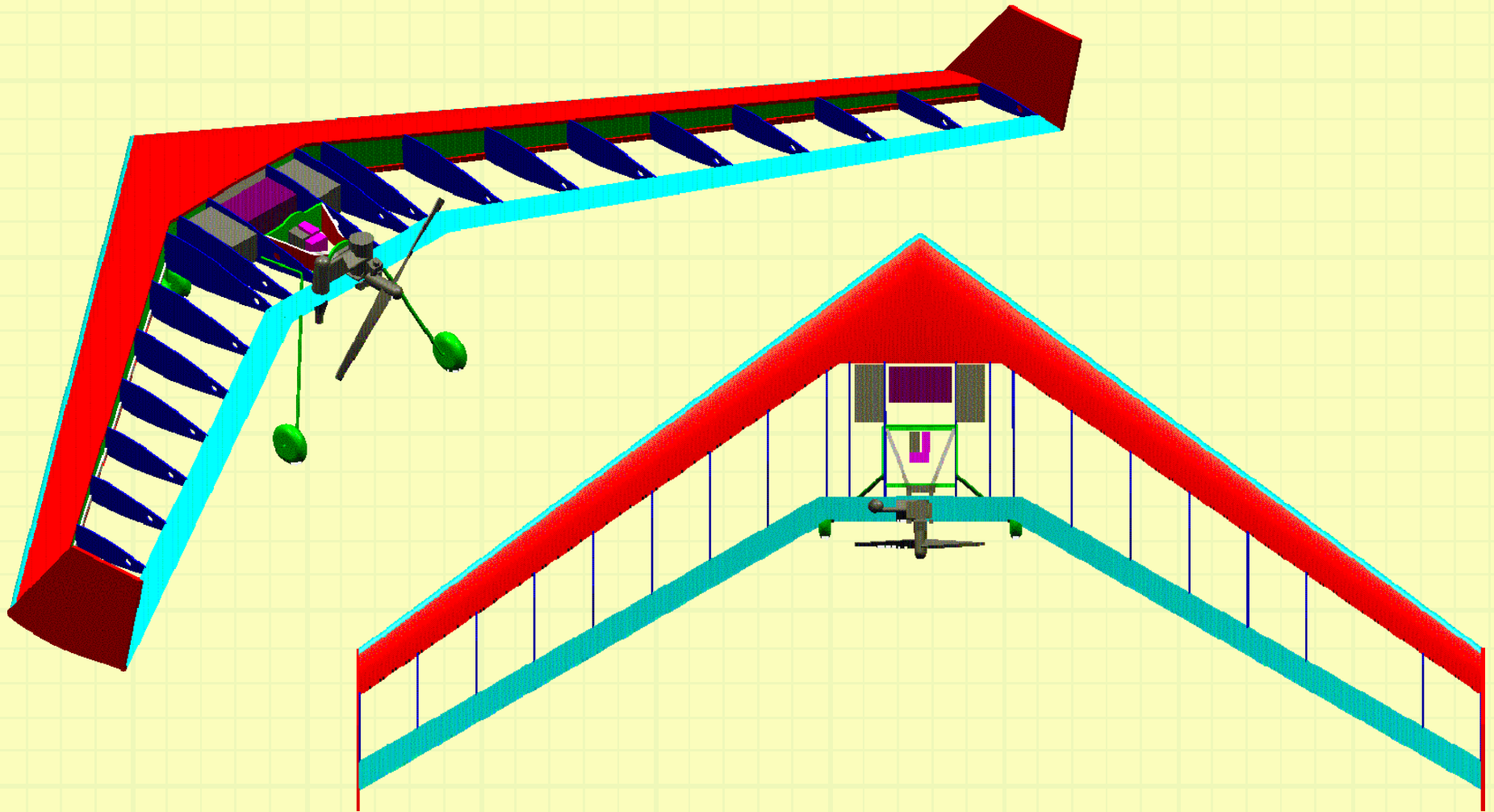# *Hodograph*
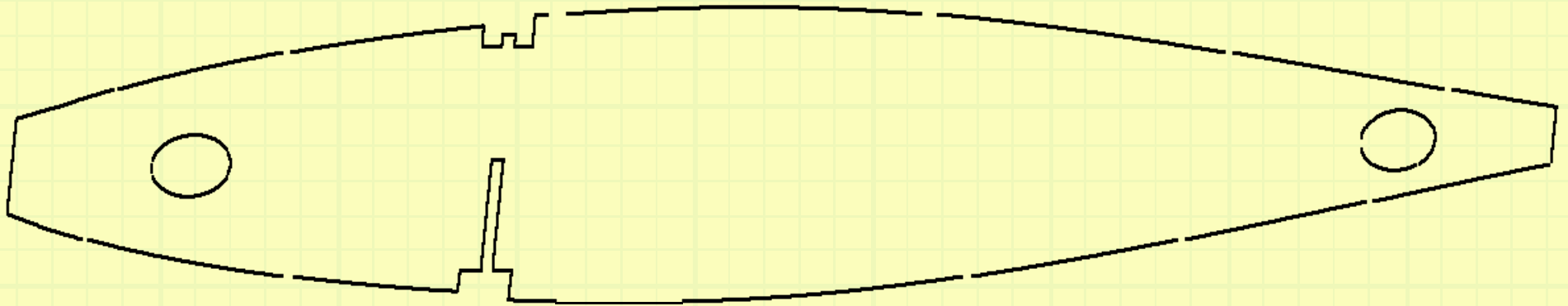


Hodograph for Ala Voladora.

# *External CATIA View*

# *Internal CATIA View*

# *Typical Rib*

# *Wing Jig*

# *Q-Bay Layout*

# *Internal Structure*

# *Ala Voladora*

# *Flying*

# *Flight Pictures*

# Unit Cost

- *Actual*        *$509*
- *Prototype*    *$50,445*
- *Production*    *$2,455*

# Actual Cost

- *Airframe*  $45
- *Construction*  $115
- *Controls*  $49
- *Propulsion*  $249
- *Shipping*  $51

# Prototype Cost

- *Parts*            *$845*
- *Engineering*     *$35,000*
- *Labor*          *$2,000*
- *Overhead*      *$12,600*

# *Production Cost*

- *Parts*            *$800*
- *Contract Labor*      *$35*
- *Labor*           *$1000*
- *Overhead*        *$620*